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The article discusses models of synchronic and diachronic phonology and suggests changes in them. The basic generative model of phonology is outlined with the author's reinterpretations. The systematic phonemic level is questioned in terms of its unreality with respect to linguistic performance and its lack of validity with respect to historical phonology. The hypothesis is presented that the set of all possible historical changes equals the set of all possible phonological rules. A revision is suggested for this hypothesis and a proof is proposed for it. (KL)

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PHONOLOGICAL MODELS

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January 8, 1967

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1.0 Introduction

The purpose of this article is to review some recent models of synchronic and diachronic phonology and to suggest modifications or reinterpretations of them. Section 1.1 outlines the basic generative model of phonology with some reinterpretations of my own. Section 1.2 discusses some aspects of the relationship between generative (competence) phonology and performance. Section 1.3 sets forth some models of historical change and the relationship of these models to my extension of the generative model. Section 1.4 presents an hypothesis that the set of all possible historical changes equals the set of all possible phonological rules, suggests a revision of the hypothesis, and proposes a proof for it.

1.1 The Basic Model

The basic model for this study is derived from the outline of generative phonology in Paul Postal's forth-coming book, Aspects of Phonological Theory.[1] Since I wish to extend some of his concepts in ways with which he would probably disagree, I shall begin with some exposition of phonology as Postal sees it.

Postal describes generative phonology as follows:

> At the start let us stress certain features of the description of a sentence in systematic phonemic terms. Within such a theory, a sentence has two crucial types of phonological structure, one the systematic phonemic, a labelled bracketing and syntactic feature analysis of the string of systematic phonemes with appropriate boundaries. Such structures are at once both the final output of the transformational part of the syntax and the input to the phonological rules. The other crucial type of structure is a universal phonetic representation providing a theory of the instructions required by the speech apparatus to produce utterances which will be tokens of the sentence. The phonetic representations are the final output of the entire set of phonological rules. The rules which connect systematic phonemic and phonetic structure form a partially ordered series ... , each rule operating on the output generated by the previously applied rule. This means that, besides the two crucial structures, each sentence has a very large number of representations,

1. Postal, Paul M., Aspects of Phonological Theory, Harper and Row, New York; (in press).

> roughly one for each operation of each rule of the phonology which must be applied in the derivation of its phonetic representation[2]

Or, as Noam Chomsky has more succinctly put it,

> The phonological component is a system of rules that relate a surface structure to the phonetic representation of a string[3]

The two levels are connected in two ways. One is through the phonological rules, the other is by the Naturalness Condition. Postal finds this hard to define, but comes close to a definition in the following statement:

> In general then systematic phonological representation makes a set of indirect claims, claims that the phonetic form of a particular systematic representation must be such and such unless there are special phonological rules which determine otherwise[4]

Postal views the systematic phonetic level as a fully specified set of instructions for the proper state of each part of the articulating apparatus; it contains sets of n-ary specifications (i.e., relative points in continua) for each phone. Chomsky says of this level:

> The final output of the system of phonological rules will be a phonetic matrix for the sentence as a whole in which columns stand for successive segments (phones) and rows define phonetic distinctive features, regarded now as scales, the entry indicating where a segment falls along a scale[5]

2. Ibid., Chp. 3, p. 1.
3. Chomsky, Noam, Topics in the Theory of Generative Grammar, 1966, Mouton and Co., The Hague, p. 76.
4. Postal, op. cit., Chp. 4, p. 13.
5. Chomsky, op. cit., pp. 76-77.

Postal proposes that at some point in a grammar (as determined by that grammar) binarily marked distinctive feature matrices will be converted by Detail Rules (D-Rules) into n-arily marked articulatory instructions. The range of values for any n-ary scale will be determined by a cross-language examination of all possible contrasting phonetic points in that continuum.[6]

For our purposes we will also need a definition of the concept "level of representation." Chomsky defines it as follows:

> That is, if we mean by the phrase 'level of representation' a system of representations that appears at some well-defined point in the process of sentence-generation, then the grammar provides no level of phonemic representation (it is difficult to imagine what other sense might be given to this expression)[7]

The two essential criteria for a level are:

1) that there be a system of representations; and
2) that the system appear at some well-defined point in sentence generation.[8]

6. Detail Rules have the property of local determinacy; i.e., they belong to some specifiable universal set and are restricted in their application such that given a binarily marked segment, there will be only one, or a small number of, Detail Rules that may apply to it; likewise, a given phone can only be the result of the application of one, or of a small number of, Detail Rules. In other words, since Detail Rules supply redundant phonetic information, abstraction of binarily marked segments from phones is often possible merely by examining the phonetic data without taking into consideration any grammatical information. (Postal, op. cit., Chp. 4, p. 14c) From this it would appear that the English stress rules proposed by Chomsky and Halle which deal with integral values on a continuum cannot be regarded as Detail Rules.
7. Chomsky, op. cit., p. 77.
8. One of the points being made in Chomsky's definition is that the representation reached in the generation of sentence X after the application of, say, phonological rule 28 is not a level of representation of that sentence because it fails the two criteria. It is not a system and the point in the generation, though easily defined, is not well-defined. 'Well-defined' is probably equivalent, in this context, to 'motivated.'

1.11 Two Levels at the Top

It has been suggested in recent generative literature that there is a level in phonology above the systematic phonemic level. In one place Chomsky says:

> The input to the phonological component I will call a phonological representation.

He footnotes this statement as follows:

> Alternatively, we might restrict the term 'phonological representation' to the representation that we have at the point at which all grammatical formatives other than boundary symbols are eliminated in favor of matrices, so that what we have is a string of phonological matrices and boundary symbols ... with IC structure ... marked. This is what is called "systematic phonemic representation" in Chomsky (Current Issues in Linguistic Theory) ....[9]

The level that Chomsky calls the phonological representation contains all the items listed in the lexicon. The system it represents will contain the same elements as the lower systematic phonemic level (and therefore fulfills condition 1) above), but a good deal happens between the two levels. The major operation to occur in that portion of the phonology is all of the strictly morphologically conditioned morphophonemics, i.e., of the

$$s\bar{i} + \text{Past} \longrightarrow s\text{ɔ}$$

type. In addition, all grammatical formatives that have phonologically conditioned allomorphs are replaced by phonological matrices. The systematic phonemic level, then, is that level of representation that occurs after the last rule in the phonology that replaces some formative with a phonological representation and before the first rule in the phonology that operates on a string composed entirely of phonological matrices, IC structure and boundary symbols. The phonological level (which I shall call the lexical level to avoid confusion) occurs just after the lexical

9. Chomsky, op. cit., p. 77.

insertion rule and just before the operation of the first rule in the phonology. (This constitutes its fulfillment of condition 2) above.) In other words, we now have three phonological levels: the lexical, the systematic phonemic, and the systematic phonetic.[10]

1.12 Two Levels at the Bottom

Postal argues at length against a fourth level, "autonomous phonemics" (old phonemics). His major argument is that a phonemic level necessitates grammars that are uneconomical (require unnecessary rules) or unmotivated (require ad hoc rules). He refers to Halle's classic example from Russian to show that old style phonemics would require a voicing rule to apply at two different places in the phonology, i.e., that a rule would have to be repeated. Chomsky[11] and others have also referred to this particular example to prove their point about old phonemics. Their argument is valid in showing that an old style phonemic solution of Russian with the condition of 'biuniqueness' would obscure the true nature of obstruent voicing in Russian. However, their claim by no means proves that no phonemic level is possible, especially if different constraints are allowed to operate in the theory. In fact, a close examination of Halle's solution will show that his solution itself obscures aspects of Russian phonology and that it may very well not be the optimal description.

Halle covers predictable obstruent voicing in Russian with the following phonological rules and definitions:

> In order to state the voicing rules in a simple fashion, it is necessary to set up the following classes:
>
> Sonorants; i.e., vowels, liquids, the glide, and the nasal consonants.
>
> Obstruents; i.e., all other morphonemes except {*v} ....
>
> Rule P 1b. Unless followed by an obstruent, {c} , {č} and {x} are voiceless ....

10. There is, of course, the physical phonetic level, but I am only concerned with phonological levels.
11. Chomsky, op. cit., p. 80.

> A single obstruent or several consecutive obstruents occurring in sequence regardless of intervening preposition or word boundaries will be termed an obstruent cluster .... (Italics in original)
>
> Rule P 2. If an obstruent cluster is followed by a word boundary or by a phonemic phrase boundary, all segments in the cluster are voiceless.
>
> Rule P 3a. If an obstruent cluster is followed by a - (dash) boundary or by a sonorant, then with regard to voicing the cluster conforms to the last segment; if it is voiced, so are all other segments in the cluster; if it is voiceless, so is the entire cluster.[12]

The first difficulty to note in Halle's solution is that Rule P 1b is not a P-rule in current practise; the voicelessness of these sounds is covered by marking theory. According to that theory the optimum obstruent is voiceless, so that the three consonants {c} , {č} and {x} will be [u voiced] before the marking conventions apply and [-voiced] after they apply. (According to marking theory, all segments must be marked for every feature by the time the phonological rules apply, i.e., these three obstruents will be [- voiced] even in contexts where Halle left them unmarked after the application of Rule P 1b.)

If the reader will now try substituting the definition of obstruent cluster for the words 'obstruent cluster' in Rule P 2, he will find the next difficulty. Apparently some boundaries are in a sense absolute, that is, voicing assimilation stops there. It is not clear from Halle's rules and definition just what this boundary is, but since he does not use the boundary symbol //#// in his description of Russian, I shall now use that symbol to indicate this absolute barrier to voicing assimilation. Stating Rule P 2 formally:

2) $[\ +\text{voiced}] \rightarrow [\ -\text{voiced}]\ /\ [\ \text{———}\ ]\ ([\text{Obs.}])_0^n\ [\ \#\ ]$

This rule is commonly referred to as the devoicing of final obstruents.

12. Halle, Morris, "The Sound Pattern of Russian," Description and Analysis of Contemporary Russian, Jakobson and Van Schooneveld, eds., Mouton & Co., 's-Gravenhage, 1959. Vol. I, pp. 63-64.

Rule P 3a says, in effect, that in an obstruent cluster preceding anything except //#//, the obstruents preceding the last one assimilate to it in voicing. Formally:

3) [Obs.] ⟶ [α voiced] / [———] [$^{\text{Obs.}}_{\alpha\text{ voiced}}$] [$^{\text{Any env't}}_{\text{except \#}}$]

Rule P 3a appears to be a neat alpha rule. There is that messy problem of stating negative environments formally, as opposed to verbally, but a way can usually be found around that problem. But is the rule really that neat? What exactly does it do? Since the voiceless obstruents are all marked as such by the marking conventions, the only effect that this rule will have on them is to voice them when they precede voiced obstruents. Note that the class of voiceless obstruents includes sounds like {t} and the defective series {c} , {č} and {x} . Rule P 3a also devoices the voiced obstruents in the opposite environment, i.e., before voiceless obstruents. Sounds like {d} , for example, will become voiceless. This means that part of the devoicing of the voiced series is put into Rule P 2 and part of it is put into Rule P 3a. Moreover, by so doing, it makes it appear that the voicing of {c} , {č} and {x} is the oddity in Russian phonology, when really it is the special devoicing of the voiced series.

Just what exactly goes on in Russian? At the deepest level, some morphemes are distinguished by final voiced and voiceless stops. For example, //Xd// ≠ //Xt//. No morphemes, however, are distinguished by distinctive voicing in the three obstruents //c//, //č// and //x//. For example, there is //Xč// but no //*Xǯ//. That is a fact about Russian. The next fact to note is that the voiced and voiceless contrasts in morpheme final position are neutralized in certain contexts. This means, in effect, that phonemic merger occurs; the only way in these contexts to find the underlying forms is by examining the other allomorphs of the morphemes. The third fact to note is that the voicing of obstruents is predictable on the basis of phonetic environment under certain conditions. This means that certain phonetic features in Russian are phonetically redundant and therefore reveal nothing about underlying form. The neutralization and and the phonetic redundancy are two different phenomena and should be distinguished in any phonological description of the language.

Halle's solution can be improved with some of the modifications to generative theory that are proposed in this paper. Rule P 2 may be reframed as follows:

2) $[\ {}^{\text{Obs.}}_{+\text{ voiced}}\ ] \longrightarrow [\ -\text{ voiced}\ ] / [\ \text{———}\ ]\ [\{\text{Obs., \#}\}]$

For example, Xd ⟶ Xt / _____ {Obs., #}.
This rule now performs the phonemic merger between the voiceless and voiced obstruents in the appropriate contexts. The Prague school would call this neutralization and would prefer to establish an archiphoneme. In generative theory that would require either a third entity or a ternary feature system; therefore, the theory requires a merger of the voiced series into the voiceless series. This merger is supported by marking theory in that the expensive member of the contrast, [m voiced], has now become the cheap member, [u voiced]. Also, some systematic phonemic //d// will become /t/ only to be revoiced in certain contexts to [d]. Therefore, this solution still seems to contain non-Russian artifacts of generative theory.

Rule P 3α will be revised as follows:

3) $[\ \text{Obs.}\ ] \longrightarrow [\ +\text{voiced}\ ] / [\ \text{———}\ ]\ [\ {}^{\text{Obs.}}_{+\text{ voiced}}\ ]$

For example, t, č ⟶ d, ǯ / [———] [$^{\text{Obs.}}_{+\text{ voiced}}$]

That is, an obstruent will assimilate in voicing to a final voiced obstruent in a cluster. There is no need to use an alpha rule because all obstruents in a position to assimilate are already voiceless. The only operation to occur is the voicing of voiceless obstruents in certain phonetic environments.

But now 2) is a P-rule and 3) appears to be a D-rule. If we choose to list the representations of forms after all P-rules have been applied and before the D-rules have applied we would have the following typical developments:

I	II	III
Systematic Phonemic		Systematic Phonetic
Xt# Xd#	Xt#	Xt#
XtObs. XdObs.	XtObs.	XtObs. - voiced XdObs. + voiced
Xtli Xdli	Xtli Xdli	Xtli Xdli
Xč#	Xč#	Xč#
XčObs.	XčObs.	Xčobs. - voiced Xǯobs. + voiced
Xčli	Xčli	Xčli

The column marked II is now an economical and motivated level between the systematic phonemic level and the systematic phonetic level.

Postal's second argument against phonemics is that any other theory of phonemics that he has considered does not include such properties as the Naturalness Condition, the Marking Conventions, or any of the other advances of generative phonological theory. It goes without saying that earlier phonemic theories were weaker for not incorporating these concepts and that any future theory must incorporate them, or something like them. It is also true that no theory of language will be compatible with speech perception and production unless extensive grammatical prerequisites are allowed in phonology. But there does not seem to be any a priori reason why a phonological theory could not have some sort of level intermediary between systematic phonemics and systematic phonetics, and still incorporate the best aspects of present theory.

In fact Postal's model of phonology contains the basis for another level of representation between his systematic phonemic and systematic phonetic levels. P-rules (phonological rules) operate with binarily valued inputs and outputs. The lowest binary output of the grammar enters D-rules which convert the binary code into values on n-ary scales. That the lowest binary output has always been considered a system is evidenced by the fact that almost all (if not all) generative phonologies have called this level the systematic phonetic level, even though the latter has been described as being at some lower point. Thus Chomsky has the rule:

(24) Consonant ⟶ [+ Voiced] in the environment / _____ [+ Voiced]

and later says of the rule

> The grammar containing rule (24) thus converts phonological to phonetic representations ... [13]

This comment contrasts with his earlier statement about phonetic scales. In other words, generativists have usually constructed their grammars on the basis of a final output of systematic representations, which coincide with this, the lowest level at which the rule output is binarily coded. A discussion of the differences between the two kinds of rules, P-rules and D-rules, will show that this level of representation also occurs at a well-defined point in the process of sentence generation.

P-rules are those rules which relate morpho(pho)nemes to the lowest binary output of the phonology. Their major formal characteristic is that they deal with binary values.[14] Their function is to change entities into already existing ones (phonemic merger) or to create new entities from old ones (phonemic split). Many of these rules will be ordered (partial ordering). P-rules also specify allomorphy. Many, in fact, require

13. Ibid., pp. 79-80.
14. Some P-rules in some languages may deal with n-ary values, e.g., rules governing stress in English.

extensive grammatical information for their formulation.[15] P-rules, in short, perform operations, i.e., are process rules.

D-rules, on the other hand, involve changes in the character of an entity rather than merger or split of entities. Ordering is artificial or impossible, so that the rules should be considered to apply simultaneously. Simultaneity of rules implies that they are not process rules, but relation statements.

Thus, P-rules and D-rules differ greatly in the values they operate with, the ways in which they operate and in their internal relationships (ordered versus simultaneous, respectively). Their interface constitutes a well-defined point in the grammar. Therefore the lowest binary output of the phonology fulfills both conditions and it must be considered to be a level in the Chomskyian sense. I shall call this level the new phonemic level. It would appear to be approximately equivalent to column II above on Page 9.

1.13 The Function of Levels

From the generative (competence) point of view, levels have no particular function in a grammar, i.e., in the generation of a sentence. I shall now consider what ramifications this four-level model may have on our understanding of performance (1.2), of historical change (1.3), and of the nature of phonological rules (1.4).

15. From the learner's (or the linguist's) point of view, the rules can only be formulated by identifying allomorphs; moreover, the fact that a given rule has applied in the case of a given allomorph is deducible only if the form is perceived to be related to another allomorph of the morpheme and if the proper base form that entails the application of the rule is posited. Thus, from the allomorph 'table' it will not be possible to infer the rule

$$u \longrightarrow ə$$

unless some allomorphy has been identified as exhibiting the relationship and if the form tabul- (as in 'tabular') has been identified as an allomorph of 'table.'

1.2 Four Levels and Performance

1.21 Some Advantages of New Phonemes

The new phonemic level will allow a strong distinction between the modus operandi of P-rules and D-rules and this has definite advantages. For example, the simultaneous nature of D-rules may allow us to assign some operations to them in order to avoid the arbitrary ordering that would be required if they were considered to be P-rules. Suppose that in a language we have the following two rules:[16]

16. Just this situation occurs in one of the Wu dialects. In Wen Zhou tone sandhi, the combination 平 + 去 yields the tones [213 + 43]. At the time that this rule occurs in a generative phonology of Wen Zhou 平 is [22] and 去 is [42]. As P-rules, the changes would be stated as follows:

Either: 1) 22 → 213/___ 42
2) 42 → 43/213 ___

Or: 1) 42 → 43/22 ___
2) 22 → 213/___ 43

(Neither order affects the rest of the phonology). However, as unordered D-rules, they would be:

$$\begin{bmatrix} +\text{ High} \\ +\text{ Falling} \end{bmatrix} \rightarrow 43 \;/\; \begin{bmatrix} -\text{ High} \\ -\text{ Rising} \\ -\text{ Falling} \end{bmatrix} \; [\;\text{———}\;]$$

$$\begin{bmatrix} -\text{ High} \\ -\text{ Rising} \\ -\text{ Falling} \end{bmatrix} \rightarrow 213 \;/\; [\;\text{———}\;] \; \begin{bmatrix} +\text{ High} \\ +\text{ Falling} \end{bmatrix}$$

The second solution accounts for the data with a minimum of theoretical artifact.

Sample Derivation:		Sample Derivation:	
	XZ		XZ
1) $X \rightarrow Y / ___ Z$	YZ	1) $Z \rightarrow A / X ___$	XA
2) $Z \rightarrow A / Y ___$	YA	2) $X \rightarrow Y / ___ A$	YA

If these operations are to be considered to be ordered P-rules they would occur in either of the two orders above (which involve changes in the specification of the environment), but would have to occur in one order. Not only are there no criteria for choosing between these alternate formulations, but it seems intuitively true that we do not want to be forced to make a choice. If the changes are formulated as D-rules with binary specifications for all of the structural description for both rules, and if the rules are applied simultaneously, the ordering problem is eliminated.

In addition, D-rules may also be required to clarify situations involving free variants. In S. E. Pomo (from a discussion by Julius Moshinsky) an epenthetic vowel, V_a, is subject to (in part) the following two rules where the first is optional:

3. c. $V_a \rightarrow e / _____ Ce$

   d. $V_a \rightarrow i / \left\{ \begin{array}{l} _____ C\{i, e\} \\ _____ y \end{array} \right\}$

so that phonetically we have both eCe and iCe but only iCi. It seems likely that a better solution would be to have one P-rule of the form

$$V_a \rightarrow V_1 / _____ CV_1$$

allowing for the sequences iCi and eCe; and then to have an optional D-rule to the effect that:

$$e \rightarrow i / _____ Ce$$

In fact, it seems likely that any optional rule is better explained as a D-rule than as a P-rule, since a P-rule covering free variants of the form

$$\alpha F_1 \longrightarrow \beta F_1$$

seems intuitively unsatisfying. On the other hand, to say that a given segment is mapped by a D-rule onto a possible series of values rather than one locus seems quite reasonable. Thus, if the D-rule relating binary features to the vowel height continuum is of the form

	[+ High, - Mid]	[+ High, + Mid]	[- High, + Mid]	[- High, - Mid]
F_{ht}	0	1	2	3
	(i)	(e)	(ɛ)	(æ)

then the rule above might be

$$[\ {}^{+\ \text{High}}_{+\ \text{Mid}}\ ] \longrightarrow [\ 0/1\ \ F_{ht}\ ]$$

with the meaning: F_{ht} has the value 0 or 1 or any value in between. This seems to accord nicely with the intuitive nature of free variants.

1.22 Some Advantages of a Mixed Lexical Level and a Weak Systematic Phonemic Level

William S-Y Wang has questioned some aspects of systematic phonemic representations as now posited by the generativists. First, many forms occur in too abstract a shape. For example, 'man' and 'cat', which exhibit no allomorphy, are nevertheless represented with an underlying back vowel that is shifted to the front along with other low back vowels that do exhibit allomorphy, e.g., the third vowel in 'telegraph' versus 'telegraphy.'[17]

17. Wm. S-Y Wang has pointed out to me personally that 'man' may have an allo-morph in such forms as 'postman.' It is not clear to me that the two forms 'man' and '-man' should be regarded as the same morpheme in a synchronic description of modern English; but if they should, I stand 'pat' on 'cat.'

This leaves us with no convenient way to deal with such variations as [p^hætiow] ~ [p^hɑtiow] for 'patio' and [pléz ə] ~ [plɑ́z ə] for 'plaza.'

Second, some types of representation may not be allowed at the systematic phonemic level, but the phonetic forms manifesting them may give no clue as to what the underlying shape should be. Thus, in English, the systematic phonemic level contains no schwa and no syllabic liquids, so that a form like 'table' must be represented with some basic vowel between the //b// and the //l//. If the 'table' we have in mind is approximately equivalent to 'chart', then the underlying vowel is //u//, as revealed by the allomorphy in 'tabular' and 'tabulate'. But what about the 'table,' that means the piece of furniture, where there is no allomorphy? Some diphthongs present similar problems. On the basis of 'righteous', 'right' is of the underlying form //rixt//. 'Rite', on the other hand, is of the underlying shape //rite// because of the vowel reduction in 'ritual.' What about 'night', 'light', 'quite' and 'white'? (Note that in some American usages 'night' and 'light' are spelled as 'nite' and 'lite', respectively.) If the systematic phonemic representation of 'produce' contains a //kt// cluster, ('production'), does 'misuse' contain one as well? If 'linear' and 'alignment' reveal the underlying forms of 'line' and 'align', what about 'sign' and 'sine'? The phonetic [z] of 'phase' reveals that the underlying form has //s//; the phonetic [s] of 'face' reveals an underlying //k//. What about the alternates [veys], [veyz] and [vɑz] for 'vase'? (I say [veys] but [veyziz].) Or [griys] ~ [griyz] for the verb 'grease' or the adjective 'greasy'?

On the basis of such examples Wang has suggested that we need to be able to represent some forms on an intermediary level in order to account for the phonological facts where there is no allomorphy. The lexical level will then contain representations of forms with various degrees of abstraction.

This leads us to ask other questions about the systematic phonemic level. If we examine individual performance, to what extent can it be shown that every speaker of a language knows every P-rule (and every form in

an underlying as opposed to a new phonemic shape) that may be posited when the language is considered as a whole? In fact, on the basis of dictionaries, extensive literature, etc., in a language, we can probably posit lexical strata, base forms and rules of an extent that may be known completely by no speaker of the language. Would such a phonology characterize the competence of a given speaker? On this subject, Wallace L. Chafe has made the following point:

> How deeply speakers delve in this direction is open to serious question. Almost certainly they do not assimilate everything that a historical linguist would internally reconstruct (comparative evidence is, of course, inaccessible to them). In all probability, too, there is variation among individuals. But the psychological validity of some underlying forms and processes of this sort is well established[18]

If we assume the validity of the new phonemic level, we can assume that a homogeneous linguistic community has the same D-rules, i.e., the same new phonemic inventory. This will be true because, from the point of view of language acquisition, it seems correct to assume that a child begins mastery of his language by eliminating redundancy which is purely phonetic and that he constructs some low level binary phonemic system equivalent to our new phonemes. This would account for a child's speaking "without accent" while continuing to make morphophonemic "errors". Then the complete phonology for that community contains all the rules and underlying forms used by anybody in that community. A description of a given speaker's competence, on the other hand, will be that set of rules which relates his underlying forms to the new phonemic forms of the language, in addition to the base forms in his lexicon that are in the less abstract new phonemic shape and undergo no phonological rules.

In other words, we are going to allow for lexical representations that occur at a well-defined place in the grammar but that do not constitute a system. Forms (morphemes) will be represented by mixed strings of new

18. Chafe, Wallace L., "The Ordering of Phonological Rules," Project on Linguistic Analysis Reports, Second Series, No. 2: October, 1967. Phonology Laboratory, Department of Linguistics, University of California, Berkeley. p. C-4.

phonemes and of deeper, more abstract segments (morphophonemes) that are provably subject to phonological rules. In addition there will be no systematic phonemic level in a strong sense because there will be lexical forms that will bypass this level of representation.[19]

1.3 Four Levels and Historical Phonology

1.31 Wang and Moulton on Historical Phonology

William G. Moulton has recently presented a traditional view of phonological change.[20] In some places he suggests that phones drift towards each other to produce phonological change; in other places his remarks point to "jump" changes.[21] To resolve the problem he points out that

19. These revisions of the typical generative model, though drastic, are derived entirely from problems and logic internal to the generative model.
20. Moulton, Wm. G, "Types of Phonemic Change," To Honor Roman Jakobson, 1967, Mouton and Co., The Hague. pp. 1393-1407.
21. Thus, Moulton, op. cit., p. 1398:
    ...this allophone become more and more similar to an allophone of some other allophone until the two become phonetically identical....
    And again, on p. 1395:
    ...two phonemes move toward each other until they merge....
    As against, p. 1396:
    In early OE, [f] and [ð] contrast both medially and finally. But then medial [f] is voiced to [v], and final [ð] is unvoiced to [f] ....
    Or, p. 1396:
    Short and long consonants thereby merged phonemically even even though they did not (yet) change phonetically....
    And to sum up, p. 1405:
    Of the ten types of phonemic change discussed above, it seems to me that nearly all must be gradual in nature, involving a considerable period of fluctuation before the new system clearly replaces the old. The only phonemic changes which may truly be 'sprunghaft', and actually take place in one jump, are those based on morphophonemic analogy.
    There seems to be a problem here with the word 'gradual.' On the one hand, Moulton could mean to indicate just phonetic drift. On the other hand, he may mean drift and/or the systematic fluctuation mentioned just a bit later.

dialectal evidence indicates that there can be systems with no change, systems with a change completed, and systems in between which display much alternation. The result seems to be that, individually, changes may be either drift or jump changes, but their effect on systems is to produce fluctuation between new and old forms.

Wang has lately proposed a model of change to resolve the problem of fluctuation. His first assumption is that:

> sound changes take varying periods of time for their operation. For lack of precise information, let us say that a sound change may take anywhere from a decade to many centuries for its operation.[22]

With reference to the ideas behind Moulton's 'gradual', 'fluctuation', and 'drift', he says of sound change through time:

> The dimension of time may be studied along each of three relatively independent parameters: (1) from sound X to sound Y, (2) from morpheme to morpheme in the relevant part of an individual's vocabulary, and (3) from speaker to speaker in the same dialect.
>
> With respect to the first of these parameters we have in mind the familiar controversy of whether the change from X to Y is gradual or abrupt...[23]

Some changes (at least) are jump changes. That is, some changes are of the form

$$[+ F_1] \longrightarrow [- F_1]$$

where no drift occurs. But changes do not at once affect all of the words in the lexicon to which they may apply. Rather the change becomes gradually more pervasive in the lexicon and the process may take centuries. Wang contends that at a later time a new, competing change, which may also

22. Wang, Wm. S-Y, "Competing Changes as a Cause of Residue," Project on Linguistic Analysis Reports, Second Series, No. 2: October, 1967. Phonology Laboratory, Department of Linguistics, University of California, Berkeley, p. W-2.
23. Ibid., p. W-5.

apply to the possible inputs to the first change where it has not been completely carried out, may enter the language. Thus in Wang's model phonemic split can occur without the Palivanov factor:[24]

> But if we accept the fact that a sound change (conditioned or unconditioned) may not complete its course due to other competing changes, then clearly we must recognize incomplete sound changes as a cause of splits.[25]

A problem from the Wu dialects may prove amenable to this analysis of split. The following correspondences illustrate the difficulty.

Dong Tong-he[26]	juo/P,T,K___	juo/P___
	uo/P,n,l,K___	uo/P,T,TS___
Proto-Wu:	*u	*ou
Su Zhou:	u	u
Wen Zhou:	u	ey

24. This is opposed to Moulton's view:
> ...such phonemic splits seem never to result from phonetic change of the phones involved...but rather from some second, quite independent change.... Moulton, op. cit., p. 1394.

25. Wang, op. cit., p. W-14.

26. This row represents Dong Tong-he's reconstruction of Middle Chinese based, primarily, on philological materials. Dong's reconstruction was used for essentially the same reasons as expressed by Kao and Mei, cf. refer to their footnote on the subject (see p. 40). In addition, a version of 方言調查字表 published in Taiwan in 1966, conveniently lists Dong's reconstructions for the 切韵 categories, and therefore for quite a few of the most common Chinese characters. Thus, use of Dong gives easy access to all of the work done on the reconstruction of Middle Chinese by all scholars.

Bernard Karlgren and others have held that this reconstructed language would account for all Chinese dialects except Min, i.e., that it would be a direct ancestor of Wu. Karlgren says:

> But the Koine [Middle Chinese] was sufficiently widespread...to have become the ancestor of nearly all of the present dialects (except the Min dialects in Fukien and adjacent regions). ("Compendium of Phonetics in Ancient and Archaic Chinese", The Museum of Far Eastern Antiquities, Stockholm, Bulletin No. 26, Stockholm, 1954. p. 212, footnote 2.)

Thus, after labials, Dong's finals juo and uo appear to merge and then split unconditionally. For example:

	1.布	2.部	3.善	4.步	5.鋪	6.譜
Dong	puo去	bhuo上	phuo上	bhuo去	phuo平	puo上
PW	pu去	bu上	phu上	bou去	phou平	pou上
SZ	pu 513	bu 331	p'u 41	bu 331	p'u 44	pu 41
WZ	pu 42	bu 24	p'u 54	bøy 11	p'øy 44	pøy 54

	7.府	8.婦	9.扶	10.夫	11.符
Dong	pfjuo上	phfhjuo平	bhvjuo平	pfjuo平	bhvjuo平
PW	fu上	fu平	vu平	fou平	vou平
SZ	fu 41	fu 44	vu 24	fu 44	vu 24
WZ	fu 54	fu 44	vu 11	føy 44	vøy 31

For items 1, 5 and 7 either the two sources for the Wen Zhou material disagree (one showing u, the other øy) or one source gives two readings (not distinguished as literary and colloquial). Moreover, for forms 5 and 6 there is data from another Wen Zhou sub-dialect that shows that u is its reflex for both PW *u and PW*ou.[27]

It may be that the u/øy distinction represents a change, u → øy, in Wen Zhou and not a difference in the proto-system. It did not affect PW *u after n, l, or the velars. It affected all PW *u after dentals and the plain dental affricates. But it affected only some of the PW *u after labials. This interpretation conflicts with the strict neo-grammarian proto-system containing two finals, *u and *ou. At

27. In addition a very old grammar (Montgomery, P. H. S., Introduction to the Wenchow Dialect, 1893, Kelly and Walsh, Ltd., Shanghai-Hongkong-Singapore) has the u/øy phonetic distinction, but some words in the grammar are not given the same final my data indicate.

present I have no way to substantiate an incomplete u ⟶ ey shift. However, it would account for the discrepancy between Proto-Wu and Dong's reconstruction. Such a procedure would also have the advantage of accounting in part for the fact that Proto-Wu is more complex than any derivative dialect.

Wang's approach also lends additional support to the concept of a mixed lexical level and a weak systematic phonemic level. If a change sets up morphophonemic alternation, then as soon as it affects several items, those items must receive a deeper underlying representation and be made subject to a P-rule, whereas the unaffected lexical items will remain in a less abstract new phonemic shape until the change spreads to them.

1.32 Chafe on Historical Phonology

Chafe has examined the notion of ordering of synchronic phonological rules in detail.[28] I shall outline some of his ideas that concern us here.

Synchronic rules may be sequentially or randomly ordered.[29] A rule is ordered sequentially with another rule if it interferes with that rule, and randomly if it does not. Even among sequentially ordered

28. Chafe, op. cit.

29. In addition there is the question of simultaneous order. Simultaneous order probably occurs historically in the sense that two unrelated changes may occur in a language at the same time, but there appears to be no way at present to determine historically or synchronically if two rules must be applied simultaneously unless they are collapsed into one rule, such as an alpha rule, where flip-flop is involved.

subsets of these rules there will be some which do not need to be ordered with respect to other subsets. Thus, rules 1), 2) and 3) and rules 4), 5) and 6) might be strictly ordered subsets, but not be ordered with respect to each other. If both subsets must precede rule 7), then the two subsets are randomly ordered with respect to each other, but strictly ordered with respect to rule 7). Chafe proposes to describe this relationship by saying that there are four depths of ordering reflected herein, rule 7) being at depth I, rules 3) and 6) at depth II, etc., with only random order between rules at any given level. Thus, graphically

Level:	Rule No.:
IV	1,4
III	2,5
II	3,6
I	7

In addition to these partially and strictly ordered subsets, there will be many rules that are in partial or strict order with no other rules; they could be considered to apply at any level in the phonology. They are considered to be randomly ordered with respect to each other and with respect to all other rules, but Chafe has questioned whether this captures all that is significant about their lack of any ordering. On the one hand, if application of rules must be sequential, and if these rules are randomly ordered within a speaker's grammar, then it would appear that he could and would apply them in different orders at different times. On the other hand, if each speaker has a fixed order, it would have to be arbitrary across the language population because there would be no principles that would lead speakers to the same ordering. Therefore, it seems quite plausible to assume that they apply simultaneously. Chafe says

> It would involve the not unlikely psychological assumption that it is easiest for people to apply rules at the same time whenever they can, that sequential ordering has a greater psychological cost.[30]

30. Chafe, op. cit., p. C-23.

Even so, we could still assume that they are all applied simultaneously with rules 1) and 4) at level IV, or at any other level, for that matter, and there still would be no principle for choosing any one alternative.

There is some evidence for supposing that these completely random rules should be applied at level I. In the first place, they all directly affect the phonetic output of the phonology because they have not been interfered with and hence ordered by another rule.[31]

> There is thus a progression from maximum concreteness (in terms of most direct phonetic relevance) in the bottom layer to maximum abstractness (least direct phonetic relevance) in the top layer.[32]

Secondly, if the hypothesis that new changes tend to enter at level I is correct,[33] then it would be a matter of chance for a new rule to create an ordering problem with some slightly older rules already stored at level I.

Thirdly, if randomly ordered rules were applied anywhere in a grammar, and if the application of any one of them occurred prior to the time when an output had been derived from all of the sequentially ordered rules, then the output of that rule would have to be stored somewhere, which would considerably complicate the performance model of language.

31. The description of this set is suspiciously like the description of the D-rules mentioned above. If most of the operations covered by these randomly ordered rules really should be covered by D-rules, then we can see why they affect the phonetic output directly, appear to be simultaneously ordered, and should be considered to apply at level I. We can also see why speakers can be assumed to know all of them -- they all have direct, observable phonetic effect.
32. Chafe, op. cit., p. C-24.
33. "I would like to assume that phonological change normally takes place through the addition of a new rule to depth I." Chafe, op. cit., pp. C-27-28.

This leaves a set of P-rules that are all partially ordered (i.e., every rule is in strict order with some other rule but not every rule is in strict order with all other rules) in a series of depths, or layers. One of the most interesting aspects of modern process-oriented phonologies is that these rules often reflect historical changes that are known to have affected the language, and that the order between strictly ordered subsets often reflects the order in which the changes appeared in the language. The deeper the level at which a rule must occur, the older is the change historically. As P-rules are pushed deeper, they do less work in the sense that they affect fewer forms and in the sense that they become increasingly less obvious from the output of the phonology.[34] When rules become sufficiently obscure they, like the Cheshire cat, having faded to aught but a smile, disappear altogether.[35]

1.33 Wu and English Examples of the Interference of the Systematic Phonemic Level with Historical Phonology

I shall now use the Halle Russian voicing type of example to show that systematic phonemicization may necessitate historically uneconomical or obscurantist grammars.

In two of the Wu dialects, we find the following new phonemic vowel plus nasal syllable finals systems:

34. As Chafe puts it:
> Obviously many old rules are sooner or later lost. Loss of a rule is not directly dependent on its degree of depth, however, but probably rather on something which can be roughly referred to as the amount of work it does in the language.

Chafe, op. cit., p. C-28.

35. Of course, the rule may be recoverable from comparison with other languages (or from dictionaries, etc.) but this does not prove that it is an active synchronic rule. (It is probably a moot point to decide at just what time the rule, like the Cheshire cat's smile, has disappeared synchronically.)

CZS	in	yn	un	CS	iŋ	yŋ	uŋ
		ən	oŋ			əŋ	oŋ
		ɑ̃				ã õ	

At the systematic phonemic level these presumably would be

CZS	iŋ	yŋ	uŋ	CS	iŋ	yŋ	uŋ
		əŋ	oŋ			əŋ	oŋ
		ɑŋ				aŋ ɑŋ	

The following P-rules would convert the final nasals as appropriate:

CZS ŋ ⟶ n / i, y, u, ə _____
ŋ ⟶ ṽ / ɑ _____
(ŋ ⟶ ŋ / o _____) (Naturalness Condition)

CS ŋ ⟶ ṽ / a, ɑ _____
(ŋ ⟶ ŋ / _____) (Naturalness Condition)

Now, historically, the CZS and CS nasals developed as follows (in general):

		New Phonemic:			New Phonemic:
CZS	*in,	iŋ —— in	CS	*in,	iŋ —— iŋ .
	*uŋ	—— oŋ		*uŋ	—— oŋ
	*un	—— un		*un	—— uŋ
	*oŋ	—— ɑ̃		*oŋ	—— ɑ̃
	*ən	—— ən		*ən	—— əŋ
	*ün	—— yn/K___		*ün	—— yŋ
	*iuŋ	—— ioŋ/K___		*iuŋ	—— ioŋ

From a comparison of the two, it is easy to see what has happened. In CZS, final dental nasals are retained after high vowels; final velar nasals remain or show up as vowel nasalization after non-high back vowels. In one case, i.e., after *i, *ŋ merges with *n. In CS, all nasals after high vowels and non-high back vowels collapse into ŋ.

But if we allow the intrusive systematic phonemic representation to enter the picture, the rules for CZS become:

some *-n ⟶ Systematic Phonemic -ŋ (Historical P-rule)
some SP-ŋ ⟶ New Phonemic -n (Synchronic P-rule)

where *-n = NP-n in most cases. This is clearly uneconomical, as well as contrary to the Naturalness Condition. Not only have two unnecessary rules been included in the grammars (one in the historical grammar, one in the synchronic grammar), but also an entity has been forced to change into something else and then back into itself.

Another problem that arises in some Wu dialects with any synchronic level above the new phonemic is with the palatal affricate syllable initial consonants. In several Wu dialects, as in Pekingese, the historical dental affricate series (TS) and the historical velar series (K) both palatalize (Tɕ) before i and/or i̯. In Wen-ling, this palatalization occurred before several yowels diphthongized into i̯ + V. In present day WL then, we have syllables of the following types:

de	tie	tø	ɦiɛ	tɕiɛ	dɣ	tɕiɣ
tse	ʑie	sø	sɛ	kiɛ	tɣ	
he	dʑie		hɛ		tsɣ	
	die					
	tɕie					
	ɦie					

The most apparent systematic phonemicization of these forms gives the following rules:

ɣ ⟶ iɣ / k ____

K ⟶ TɕV / ____ i̯V (= iɣ)

TS ⟶ TɕV / ____ i̯V (= ie, iɛ)

When we examine the situation historically, however, we note that

1) we now need historical rules like *K ⟶ TS (and TS ⟶ TÇ, synchronically) which seem very unlikely, and,
2) no historically plausible stage corresponds to our systematic phonemicization of the data, as a level.[36]

Without the systematic phonemic level, the data are accounted for as follows: the following historical P-rules apply to the appropriate proto-forms to yield new phonemes (ordering is indicated in the Chavian manner):

IV eu, Au ⟶ ɣ A ⟶ e en, æn, e/æn ⟶ ie

an ⟶ ie/ʔ, h ____ An ⟶ a/f ____ æ ⟶ iɛ/TS ____

⟶ ø/elsewhere ⟶ ɛ/elsewhere

III ɣ ⟶ iɣ /P, K (stops) ____

II TS, K ⟶ TÇ/ ____i, i̯ TS ⟶ TÇ/____y, y̯

I əʔ ⟶ iəʔ /K (stops) ____

e ⟶ ie / "

ɛ ⟶ iɛ / "

The following sample derivations illustrate the points made above. The first column contains a Chinese gloss and a proto-form; the numbered columns provide the output after the application of all the rules in a given level. The column labeled I is the new phonemic level. The column on the far right is the systematic phonemic solution presented above.

1 36. Chafe says of underlying forms:
> Let us pretend at first that there is a complete correlation between underlying phonological forms and historically earlier forms in a language, and between the phonological rules which lead from such underlying forms to phonetic forms and the historical changes which led from earlier forms to those presently in use.

Chafe, op. cit., p. C-4.

	Proto-form	IV	III	II	I	Systematic Phonemic
1. 袋	*dʌ	de	de	de	de	de
2. 裁	*tsʌ	tse	tse	tse	tse	tse
3. 改	*kʌ	ke	ke	ke	kie	kie
4. 海	*hʌ	he	he	he	he	he
5. 店	*tæn	tie	tie	tie	tie	tie
6. 前	*zæn	zie	zie	ʐie	ʐie	zie
7. 纏	*dʐe/æn	dʐie	dʐie	dʐie	dʐie	dzie
8. 電	*den	die	die	die	die	die
9. 箭	*tsen	tsie	tsie	tɕie	tɕie	tsie
10. 薦	*ken	kie	kie	tɕie	tɕie	tsie
11. 短	*tɑn	tø	tø	tø	tø	tø
12. 酸	*sɑn	sø	sø	sø	sø	sø
13. 旱	*ɦɑn	ɦie	ɦie	ɦie	ɦie	ɦie
14. 藍	*lʌn	ɦlɛ	ɦlɛ	ɦlɛ	ɦlɛ	ɦlɛ
15. 三	*sʌn	sɛ	sɛ	sɛ	sɛ	sɛ
16. 間	*kʌn	kɛ	kɛ	kɛ	kiɛ	kiɛ
17. 鹹	*ɦʌn	ɦɛ	ɦɛ	ɦɛ	ɦɛ	ɦɛ
18. 姐	*tsæ	tsiɛ	tsiɛ	tɕiɛ	tɕiɛ	tsiɛ
19. 頭	*deu	dɣ	dɣ	dɣ	dɣ	dɣ
20. 斗	*tʌu	tɣ	tɣ	tɣ	tɣ	tɣ
21. 走	*tsʌu	tsɣ	tsɣ	tsɣ	tsɣ	tsɣ
22. 搜	*ʂʌu	sɣ	sɣ	sɣ	sɣ	sɣ
23. 狗	*kʌu	kɣ	kiɣ	tɕiɣ	tɕiɣ	kɣ

Note that the right hand column matches no other column in the chart.

Form 10 illustrates the *K ⟶ TS shift.

Similarly unhistorical forms and rules present themselves in English. One of Chomsky and Halle's contentions about English[37] (in a simplified form) is that in the French sector of the vocabulary an intervocalic [s] reveals an underlying //k//, whereas [z] reveals an //s//. But some forms are aberrant. 'Ace' has [s] and that and the spelling indicate an underlying //ake//. Historically, however, the ME form is 'as, aas' from OF 'as.' For 'ace' then it would appear that historically *s ⟶ //k//, and synchronically //k// ⟶ [s]. Similarly 'race' contains an underlying //k// (as does 'face') but historically an *s (as opposed to 'face' < VL *facia which has a [k] in its ancestry. 'Rice', 'rise', 'ruse', and 'muse' further substantiate the anomaly. Do we really want an historical rule for English of the form *s ⟶ //k//?

1.4 Four Levels and the Hypothesis of a Universal Set of P-rules

1.41 The Hypothesis and its Proof

It has been alleged by Paul Kiparsky that Halle has claimed that the set of all possible synchronic rules equals the set of all possible historical changes.[38] The truth of the allegation will not be discussed here; but the claim is an interesting one -- after all, an examination of any fairly large number of historical and synchronic phonologies will reveal quite a few rules which appear in both types of phonologies.

If the claim were true, how would we prove it? Mathematically, the proof would consist of showing that any arbitrarily-chosen member of Set A is included in Set B, and vice versa. The problem for linguistics is essentially how to describe the two sets so that, given any phonological

37. Chomsky, N. and Halle, M., The Sound Pattern of English, Harper and Row, New York (in press).
38. Kiparsky, Paul, "Linguistic Universals and Linguistic Change," (To appear in Proceedings of the Texas Conference on Language Universals, ed. by E. Bach and R. Harms).

rule, we can determine whether it is a possible historical or synchronic rule, i.e., whether it has the properties that allow it to be classed as a member of one set or the other. In short, just what is a phonological rule, historically or synchronically?

I shall now propose a definition of membership in either the synchronic set or the historical set in such a way that it will be seen that the question is not really whether the two sets are equivalent, but instead whether there is only one universal set of all possible phonological rules. A P-rule is one which has the following qualities:

1) It is a process- or rewrite-statement to the effect that A is changed into (rewritten as) B.
2) The values encoded on both the left and the right hand side of the rule must be on the same phonological level. In generative terms, this means that the input and output of the rule must be binarily-coded distinctive feature matrices.
3) The rules must change one entity into another. That is, they must create new contrasting phonological entities (phonemic split) or erase previously existing contrasts (phonemic merger).[39]

Detail rules must be excluded from the set for two reasons. In the first place, phonetic drift in the D-rules will not become important historically until it is sufficient to be converted into an ordered P-rule. In the second place, D-rules involve factors such as the nature of the articulatory mechanism, and the nature of economy in human speech. Changes that affect these factors must be said to occur in evolutionary time and are related more to the universality of the phenomenon of human language than they are to the diversification of different human languages.

39. Nothing in the above statements refers to environments. It may be possible to make statements concerning some of them at some future time, but at present most appear to be so random, accidental, and language-specific, as to be impossible to include in a universal theory.

Rules between the Lexical level and the Systematic Phonemic level must also be excluded. Two English rules of this type will show why:

1) sī + Past ⟶ sɔ
2) Past ⟶ D/elsewhere

There is no reason why any other language should have rule 1) since both 'sī' for 'see' and the presence of a unit 'Past' in the language are both part of the arbitrariness of language. As for rule 2), even if some other language has 'Past' there is no reason why its regular realization should be //D//, e.g., cf. Latin 'bā'. In short, these rules are only semi-phonological in that, unlike the P-rules, they operate with a binary output but not a binary input.

1.42 Why Counter Examples Don't Count

It is easy to see that defining the set is the central problem and that counter examples are not relevant to the issue. In the first place, there are two ways to define sets, one by listing all the members and the other by listing the defining qualities that allow membership in the set. If we could list all possible synchronic P-rules and all possible diachronic P-rules now, the theoretical question could be answered forthwith; since we deal in an unfinished empirical science, complete listing is not possible. Hence there is always the possibility that a rule in one set or the other that at present does not appear to have a counterpart in the other set may actually be given one in the future when more is known about more languages. But even more important, our understanding of the best possible formulation of the rules in either set is so deficient at present that we could never be sure that a rule with no evident correlate in the other set is not just poorly composed. Therefore, at the present time, we must establish the set by definition rather than by listing all possible members.

Three brief counter-examples to the hypothesis that have been proposed

deserve mention here.[40] The first concerns a language with personal prefixes to the verb with the alternant forms CV and VC (where CV is singular and VC is plural). It has been proposed that the best synchronic description of these facts is a methathesis of one prefix into the other. This solution, however, raises more questions than it answers. First, is the metathesis a phonological rule, a grammatical rule, or a semi-phonological rule? Second, if metathesis is the best solution, on what grounds will one order be chosen to be metathesized into the other? Third, why is metathesis to be chosen over deletion (i.e., CVC $\longrightarrow$ CV, VC) or insertion (i.e., V $\longrightarrow$ CV, VC)? None of these questions can be answered until more is known about the language in question, both synchronically and historically, and until more is known about phonology. It is true that the present tenets of phonology incline us to feel that metathesis of true vowels and consonants does not occur historically, but this prefix system cannot be justifiably regarded as a counter-example to the hypothesis.

The second counter-example is the collapsing of rules in a given description in a way that does not find its counterpart in some other description. Thus, a rule essentially of the form k $\longrightarrow$ s is presently being posited for synchronic English morphophonemics, but there are at present no known cases of such a direct shift in historical grammars. Rather, a more likely historical pattern is k $\longrightarrow$ t$\int$ $\longrightarrow$ $\int$ $\longrightarrow$ s, or something of the sort, but there is no evidence in modern English for such a chain of small changes.[41] The question that arises is this: If synchronically we are motivated to posit just k $\longrightarrow$ s, but historically always the longer chain, does this not constitute a clear case where the sets are not equivalent? First, it is always possible that some language will turn up an historical

40. The first two counter-examples are from Wm. S-Y Wang.
41. It turns out that the counter-example is slightly fictitious anyway. English was never subject to a historical k$\longrightarrow$s change; it borrowed the rule from French when it borrowed the forms revealing the rule. French was subject to an overall k$\longrightarrow$s shift and the investigation of the intermediate steps involved (if any) must be resolved in Romance philology.

k ⟶ s rule. Second, this type of counter-example would be of theoretical value only if the shorter form were essential, i.e., if the longer form would interfere with other rules in the phonology. Until this is shown to be the case, I shall assume that the longer and shorter rules are equivalent. A short rule will be said to be equivalent to a longer chain of rules when:

1) The highest left side and lowest right side of the longer chain of otherwise motivated rules are the same as the left side and the right side of the short rule, and
2) the longer chain is closed in the sense that the leftmost input is the unique source for the rightmost output, and that no quantity in the longer chain of rules gives rise to an entity other than the rightmost output.

A third type of linguistic change that has been proposed and that would invalidate the set hypothesis is rule reversal. If there is an historical rule that relates two dialects by reversing the order of two rules in one of them, then that reversal rule would not belong to the set of possible synchronic rules. Kiparsky felt that such a change had occurred in some German dialects.[42] These dialects have the underlying morpheme 'spāt' which can occur before juncture and before certain umlauting suffixes (herein symbolized as # and X respectively). Dialect A has the two following rules:

1)	Umlaut before X	giving the forms	spāt#	spätX
2)	ā ⟶ ɔ̄	"	spɔ̄t#	spätX

Dialect B has the rules in the reverse order:

1)	ā ⟶ ɔ̄	giving the forms	spɔ̄t#	spɔ̄tX
2)	Umlaut before X	"	spɔ̄t#	spötX

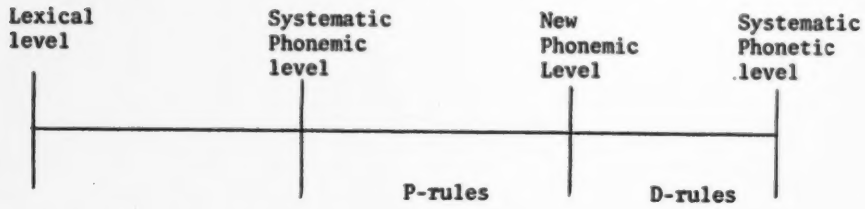
However, it appears more plausible to assume that the second dialect has

42. Kiparsky, op. cit.

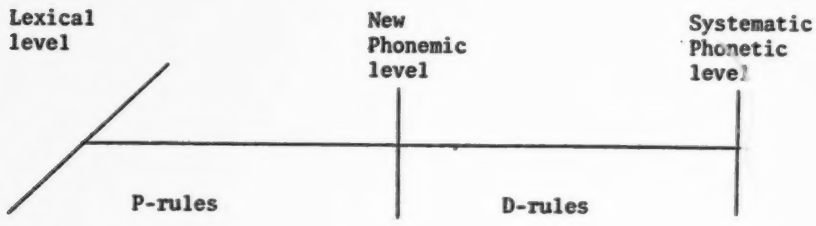
merely dropped the first rule and restructured the lexicon.[43] This seems especially true in view of the fact that these two sets of rules proposed by Kiparsky are supposed to be synchronic rules, when in fact rule 1) in Dialect B is recoverable only in comparison with other dialects, and not internally.

1.43 A Composite Model of an Organic Phonology

The modified synchronic model presented in 1.1 is of the form:



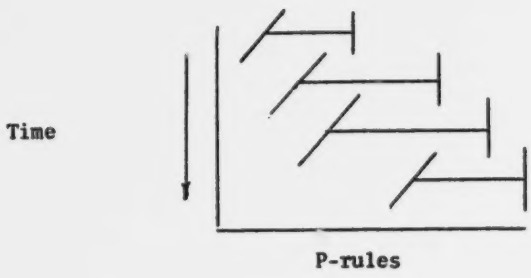
In sections 1.2 and 1.3 I suggested that the systematic phonemic level should be considered either as a weak level or as non-existent. To emphasize its mixed nature and the semi-phonological nature of the rules between the lexical level and the systematic phonemic level, I shall revise this model as follows:



Now, if through time, new P-rules enter a language at level I either directly (jump change) or via the D-rules (drift change) and are dropped from the deeper layers of the phonology, it would seem that a

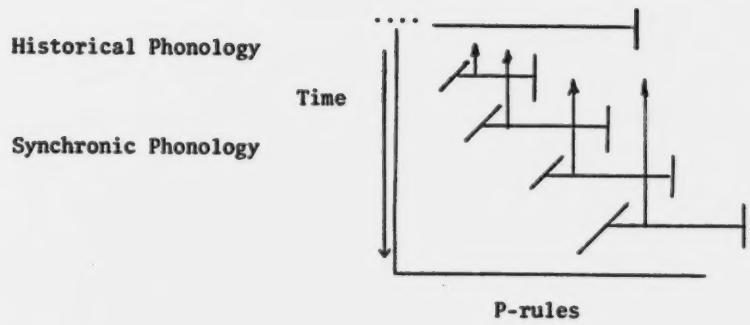
43. This in brief is Chafe's solution to the same problem, Chafe, op. cit., pp. C-30 ff.

synchronic phonology is continually deleting and adding rules. Graphically:



As rules are dropped, they are 'picked up' by the historically recoverable phonology, the number of rules in which is limited only by how much we know about the language.[44] Graphically:

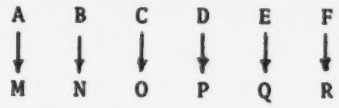
44. As Chafe points out, this does not mean that the historical phonology and the synchronic phonology of the same language differ only in size. In the first place, the semi-phonological rules represent semi-regular historical change. Moreover, Postal suggests in his book that synchronic phonologies must include exception rules, which in general are morphological properties written as instructions to the grammar to violate some rule with respect to certain morphemes. These rules have their historical equivalent in that it is frequently possible to posit a proto-form for some morphemes, where some of the compared languages show irregular forms that would indicate a proto-form of a different shape. In other words, they may be said to apply an exception rule to given morphemes to the effect that they are irregularly shifted from their correct correspondence to another one. In addition, ordering in the historical phonology will be internally determined and will not necessarily reflect the order in the synchronic phonology or the order of loss.



The only difference between the various sets of P-rules will be what data are examined, i.e., not only will historical P-rules and synchronic P-rules not differ in kind, but synchronic P-rules will be seen as the tail-end of the historical P-rules.

The relaxation of the diachronic/synchronic dichotomy which this model represents is a necessary step in advancing our concept of phonology.[45]

Before Saussure there was essentially no place in linguistics for synchrony. Language was described in terms of change in positive entities. Graphically:



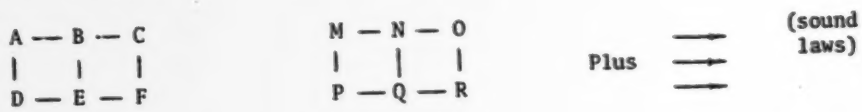
Saussure and later structuralists developed the concept of a system, the members of which were defined solely by their interrelations. In other

45. Chafe says:

> It is my view that general historical factors, factors of language change which are familiar to all linguists, suffice to show why non-phonetic structures must be recognized in language, why they should be of a particular kind, and why they should be related to each other and to phonetic structure in a particular way. Only an unfortunate over-emphasis of the distinction between synchronic and diachronic linguistics was for some time able to obscure the otherwise rather obvious consequences which 'sound change' has for the nature of phonological structure.

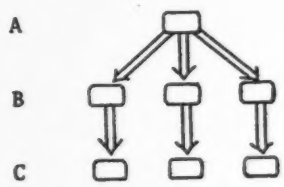
Chafe, op. cit., pp. C1-2.

words, systems contained negative oppositions and were not inventories of positive entities. Synchronic analysis pertained to static systems at various time depths; diachronic analysis was a separate field altogether. Graphically:



Modern process phonologies have combined the two earlier models. They contain two or more synchronic systems which are interrelated by semi-historical phonological rules. Graphically:

Using this model, if we were to compare a set of *genetically related* languages, we would have, schematically:



where B (underlying phonological forms) to C (new phonemic level) represents the usual process phonology of a distinct language and A (proto-system) to B represents the greater historical depth we can reach by comparison.

This model accounts for historical change in various ways. One way is for small, gradual, but accumulative changes to occur in the exact n-ary value of a new phoneme in some continuum until it interferes with the n-ary value of another new phoneme. Another way would be for a language to start operating the D-rules in such a way that two of them would have to be strictly ordered, with the result that one would enter an upper level as a P-rule, i.e., become a systemic change. A third would be for some new

rule to enter directly at level I. A fourth would be for a rule to drop with consequent restructuring of the lexicon.[46] Chafe has also mentioned another kind of change: conversion of a transient rule into a persistent rule. The total effect is for changes to enter at or near C, to move towards B and then to drop off into A-B.

The organic model described above also accounts for the hypothesis of the universal set in that it shows why historical P-rules must be the same as synchronic P-rules.

1.5 Review and Conclusion

1.51 Three Levels for Performance and History

I have questioned at length the extent to which the systematic phonemic level constitutes a real linguistic level. In a description based on a widespread corpus from a language of a civilization with extensive literacy and a large literature, the systematic phonemic level cannot be regarded as necessarily valid for any given speaker of that language. It seems more likely to be the case that some speakers, if not all, will have representations of some morphemes in a shape no more abstract than the new phonemic. This set of morphemes will be entirely idiosyncratic to each speaker.[47] In addition, the systematic phonemic level may cause us to make statements about a language that are historically invalid, and may, indeed, complicate our description of how the modern language developed from some ancestor. If the systematic phonemic level were really a level and a uniform system of entities, which were entirely synchronic in nature, then there should be perfectly convincing ways of relating such

46. As Chafe puts it:
> One kind of phonological change, then, is the loss of a phonological rule and an accompanying change in some underlying forms. (op. cit., p. C-30).

47. In the sense that there will be no universally valid way for the linguist to show that the speakers have been exposed to the necessary data to give them the opportunity to form a morphophonemic rule covering the forms, and/or give the morpheme a more abstract underlying shape.

systems at various time depths to each other. But we have no historical generative instructions to drop rules, add rules, or rearrange rules. All we have for historical generative rules, are, in effect, instructions to restructure the lexicon, which are rescriptive themselves, just as are the synchronic rules.

1.52 The Putative Systematic Phonemic Level

However, the systematic phonemic level in our model did have the value of indicating the upper limit of the universal P-rules. This may be the reason why it was ever considered a level at all. It performs little work in a competence grammar and it may have appeared as a level only because the generativists intuitively recognized the essential difference between the language-specific semi-phonological rules and the universal P-rules. The problems with its relationship to performance and history arise when it is forced to become more than it really is. Even though the putative systematic phonemic level appears at a well-defined place in sentence generation, it is not a system. It contains more or less haphazard relics of an older system (or older systems),[48] that is items of various depths, so that synchronically it is not a level.

1.53 The Collapse of the Dichotomy Between Synchrony and Diachrony

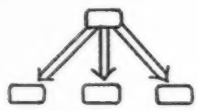
Since the systematic phonemic level in terms of performance is too abstract, psychologically unreal, arbitrary and indeterminate, and since in terms of historical phonology it is uneconomical and obscurantist, it must not be a linguistic reality. What we can say is that some morphemes in a language have underlying shapes which are more abstract than the underlying shapes of other morphemes. The rules that relate these more abstract forms to their surface shapes belong, in part, to a universal set. These rules explain synchronically the current relationships between

48. In proto-languages it may be possible to posit a certain phonetic relationship among elements A, B and C, and another relationship between X, Y and Z, but it will often be impossible to prove that the relationships A-B-C and X-Y-Z must have co-existed in one system. The same holds true of the systematic phonemic level.

entities in the surface system; historically, they are the most recent changes that have occurred in the language.

The result is that, just as the generativists have shown that there is no level between the systematic phonemic and systematic phonetic levels to accommodate the earlier phonemic level, in the same way there is no natural point in a phonology where we can show absolutely that prior to that point we have diachrony and following it, synchrony. We can further simplify the diagram on page 37 to:

A



C

where C is the new phonemic level.

A is itself arbitrary as a level (the limits on its depth are extra-linguistic, i.e., dependent on the choice of data). A form in a phonology will have a representation on level C and may have a deeper underlying form. But there is no level between A and C that contains elements of which all forms in the language must be composed.

THE CHINESE LINGUISTICS PROJECT

The Chinese Linguistics Project was started in the Spring of 1966, financed by a Ford Foundation grant. Although it is situated at Princeton, it was conceived as a national center designed to serve national, and indeed international, needs in the general field of Chinese linguistics.

The Ford Foundation funds cover five years of operation and are allocated to the conduct of a Seminar composed of permanent Project staff, interested Princeton faculty members, and five or six scholars who reside at Princeton for varying periods, usually a year, to work on their own research. There are also a series of projected programs in pure and applied linguistics: A computer count of Modern Vernacular Literature Chinese (MVL), a students' glossary of MVL based upon that count, and two curricula in written Chinese keyed to that glossary. The computer count will also be extensively exploited for various uses in sample concordances, stylistic analysis, research on word combinations, and so on.

The Project has an ambitious publication program, including the UNICORN pre-print series, teaching materials (the initial volume, T. T. Ch'en's Tarn Butyng, is already out), and theoretical or infrastructure contributions to the Chinese linguistics field.

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